

Interactive comment on “Ocean forced evolution of the Amundsen Sea catchment, West Antarctica, by 2100” by Alanna V. Alevropoulos-Borrill et al.

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1 Overview

In this work, the authors present projections of evolution of the Amundsen Sea Catchment of the Antarctic Ice Sheet (and resulting contributions to global sea levels) under a range of climate forcings provided by CMIP5 global circulation model simulations. The specific model results used are based on assessments of model skill in the Southern Ocean, and subshelf melt-rate forcing is computed based on model-computed ocean temperature anomalies. There is also a fairly careful study of the effects of uncertainties in the initial problem setup due to the parameter estimation (via inversion) required for the initial model state to match present-day observations.

C1

This is a very nice paper, for the most part well-written and clear. With some exceptions (outlined below), the methods used are clearly documented, the results are presented clearly, and the discussion is thoughtful, careful and clear. I have only minor suggestions as listed below, and would support publication once these are addressed.

2 General Comments

My main high-level suggestion is to consider including the dependence on initialization that you demonstrate as a key point. As a modeler, I think this is a major takeaway from this article – you demonstrate how projections can be very sensitive to something which is almost always only mentioned in passing and can be something of a dark art. You even make it the final sentence of the paper, which indicates its significance.

After reading the article a few times and also looking at Nias et al (2016), I admit that I'm confused as to whether you're running full-continent AIS simulations while forcing only in the ASE sector, or if you're running a regional model. I think it's the former, but that should be clarified.

Graphs in my preprint are too small to read easily when printed on paper. They should be larger in a final printed version.

3 Specific Comments

1. line 55: Seroussi and Morlighem (2018) is an odd reference to use here, since that work focused primarily on evaluating approaches to discretizing subshelf melt in ice sheet models, not the effects of subshelf melting in general.
2. line 219: I'd suggest the use of "finest" instead of "maximum" when discussing

C2

resolution.

3. line 253: I don't think "accounted for" is the right way to say this. Perhaps "addressed by"?
4. line 257: What is r ? Did you mean b (bedrock)? (would it be simpler to simply say "grounded" and "floating"?)
5. section 3.2: As I mentioned in the general comments above, I *think* you're running on a whole-continent AIS domain, but I don't think you explicitly say that anywhere (apologies if I missed it). In this section, it would be helpful if you can provide the following:
 - (a) Explicitly state which domain you're solving on (a picture with your initial velocity field might be helpful here).
 - (b) Are you modifying the state outside the ASE in any way? (For example, in other works, BISICLES has been run with high friction values imposed outside the catchment of interest to "turn off" the flow there, isolating the flow to the single catchment – are you doing anything like that here?)
 - (c) What are you doing for marine forcing outside the ASE?
6. line 356: You might also consider citing the recent paper by Gudmundsson, et al (2019) here.
7. line 366: I'd suggest rephrasing "...grounding line retreat in 2100 relative to...", possibly as "grounding line positions in 2100 which are retreated relative to..."
8. line 367: I'd suggest rephrasing "The individual ice stream response...", possibly as "Response of the individual ice streams..."
9. lines 489-513: This paragraph doesn't read as well as the rest of the paper and could use some editing for clarity.

C3

10. line 492: This sentence is a bit convoluted. I think you meant to say "instead performing" instead of "instead of performing", perhaps?
11. line 495: In fairness, our catchment-independence results in the 2019 GRL paper suggest that you're safe doing basin-scale models for $O(100)$ years or so.
12. line 526: As I mentioned above, I think this is a key point of your work here (and should be consequently included in the "key points" at the beginning).
13. Table 1: It's odd that the basal traction isn't monotone as you progress from low-end through optimum, median, and high-end, the way all of the other parameters are. It might be helpful to comment a bit more on that. Are there other ensemble members which have similar "high-end" responses while also being monotone in all of the quantities, relative to the other cases? As you discuss in the text, this case is interesting because it helps set off the competing impacts of varying friction vs. viscosity, but on the other hand, it might obscure more basic relationships in these quantities.
14. Figure 5: It would be useful if you labeled various ice streams (and other features) referred to in the text in at least one frame of this figure.

4 Technical Comments

1. line 50: Formatting is odd here, with 2 words and the remainder empty space. Perhaps an errant line break?
2. line 199: missing period at the end of the sentence.
3. line 224: The formatting of this equation is off – the dot for the divergence appears to be a period. If you're using latex, use the `\cdot` character; in MS Word, there is a dot-product dot in the math character set.

C4

4. line 241 (eqn 3): More equation formatting. Along with the dot-product issue already mentioned above, I'm confused by the character above the viscosity (μ). I think it's meant to be the overbar (indicating vertical averaging?). Finally, there is an accent over ϵ , rather than what's generally a time-derivative dot. (in latex, `\dot{\epsilon}` produces $\dot{\epsilon}$. In MS-Word, there is a way to do that using equation formatting.)
5. line 248: There should be a comma between "n=3" and "satisfies".
6. line 257: Formatting for this set of cases is a bit off (too crowded, vertically) – this is true for equations 6,7, and 8.
7. line 269: Same issue with the dot-product formatting.
8. line 272: "...above, BISICLES..." → "...above, the BISICLES..."
9. line 276: "...results of initialization" → "...results of an initialization..."
10. line 284: I'd suggest "consistent with present day observations"
11. line 301: I don't think you need (or want) a comma after "forcing"
12. line 368: "response... differs"
13. line 378: I don't think "denote" is the right word here; perhaps "indicate"?
14. line 393: should it be "has a lesser", or "have a lesser"?
15. line 400: I'd suggest commas after "Pope" and "Smith"
16. line 450: I'd suggest "response" instead of "behaviour"
17. line 463: Do you mean fig 6b here?

C5

18. line 479-484: This is a pretty long sentence...
19. line 482: "models... produce"
20. line 483: I think the semicolon should be a comma here, since what comes after isn't an independent clause...
21. line 485: "responses... illustrate"
22. line 486: (same thing) "responses ... highlight"
23. lines 498-499: I think this is a sentence fragment.
24. line 508: "captured by the within model configuration"?
25. line 512: "our range... is marginally..."
26. line 516: Do you mean fig 6b here?
27. line 550: "cavity resolving" → "cavity-resolving", perhaps?
28. Figure 6 caption: Did you mean the "400-00m layer" as stated, or is there a typo?

5 References

1. G. Hilmar Gudmundsson, Fernando S. Paolo, Susheel Adusumilli, and Helen A. Fricker. "Instantaneous Antarctic ice sheet mass loss driven by thinning ice shelves". *Geophysical Research Letters*, **46**(23):13903–13909, 2019.